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Doll et al.

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(54) **FLUID CONVEYANCE SYSTEM**

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(51) **Int. Cl.**

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E02F 3/30	(2006.01)
E02F 3/46	(2006.01)
E02F 9/22	(2006.01)

(52) **U.S. Cl.**

CPC . ***E02F 3/36*** (2013.01); ***E02F 3/304*** (2013.01); ***E02F 3/46*** (2013.01); ***E02F 9/2271*** (2013.01); ***E02F 9/2275*** (2013.01); *Y10T 137/85978* (2015.04)

(58) **Field of Classification Search**

CPC E02F 3/304; E02F 3/651; E02F 3/3663
USPC ..... 92/110–112, 117 A; 137/580; 138/42, 138/114, 115, 118–120; 414/685, 690, 414/695.5, 699, 708

See application file for complete search history.

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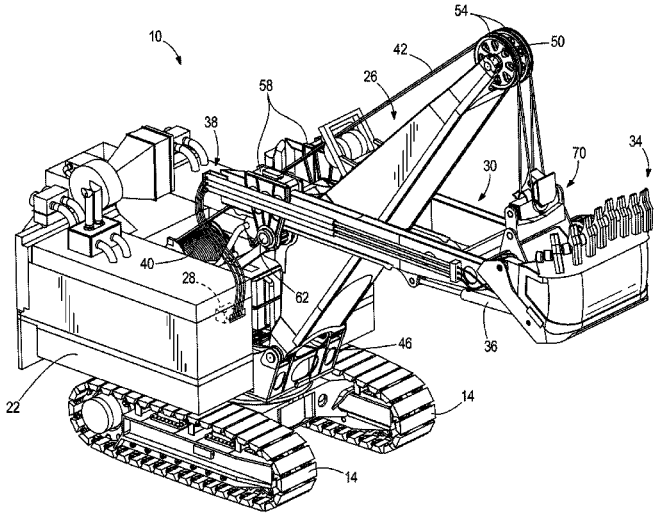
(57) **ABSTRACT**

An industrial machine includes a frame supporting a fluid source and a boom, an arm, an attachment coupled to the arm, a cylinder, and a rod. The arm is movably coupled to the boom for translational and rotational movement relative to the boom. The cylinder includes a first end and a second end, and the cylinder defines an internal bore in fluid communication with the fluid source. The rod is coupled to the arm and is slidably received within the cylinder. The rod includes a port and a passage for providing fluid to the attachment. The port provides fluid communication between the internal bore and the passage. The port is positioned within the internal bore throughout the entire range of movement of the rod relative to the cylinder.

20 Claims, 6 Drawing Sheets



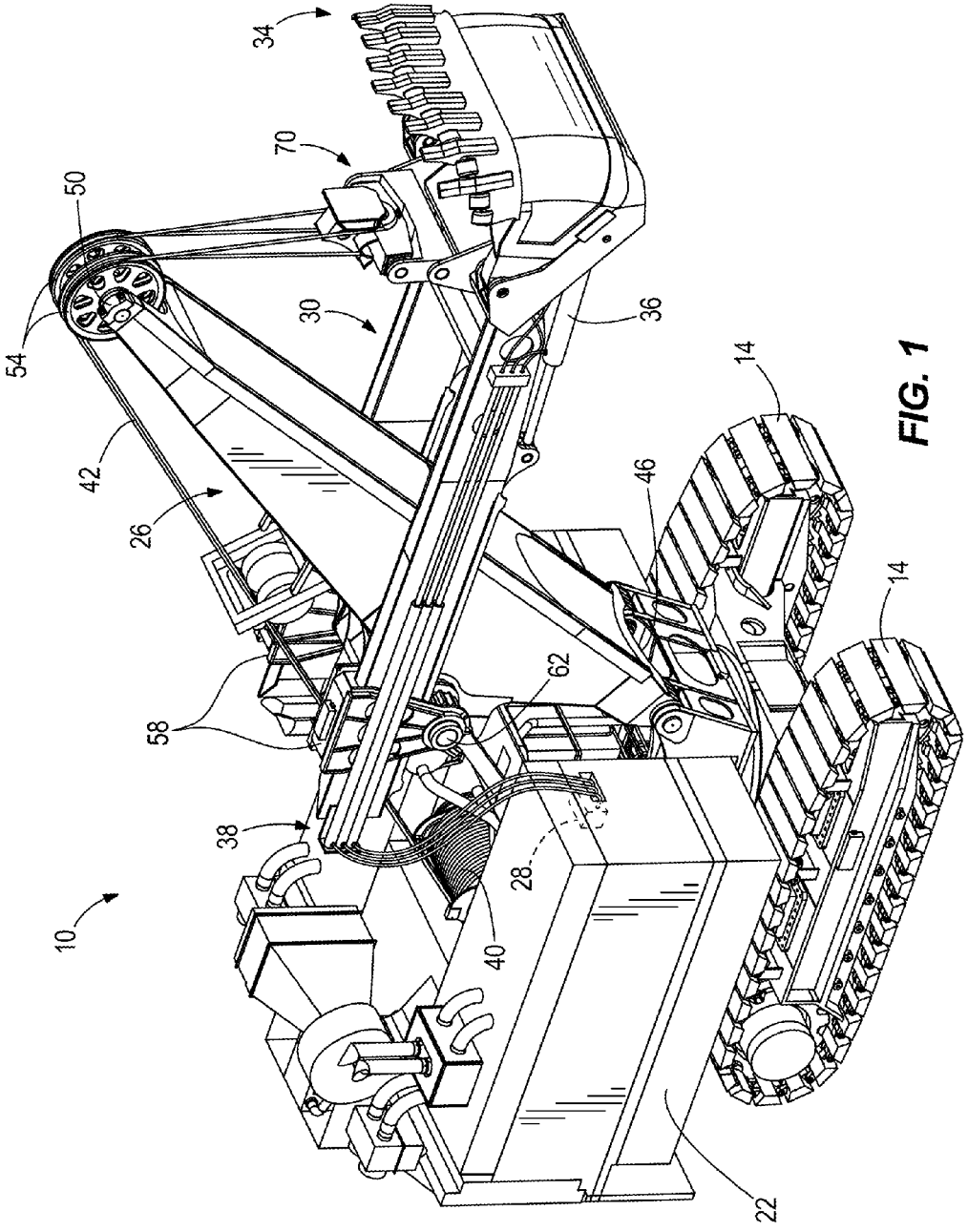


FIG. 1

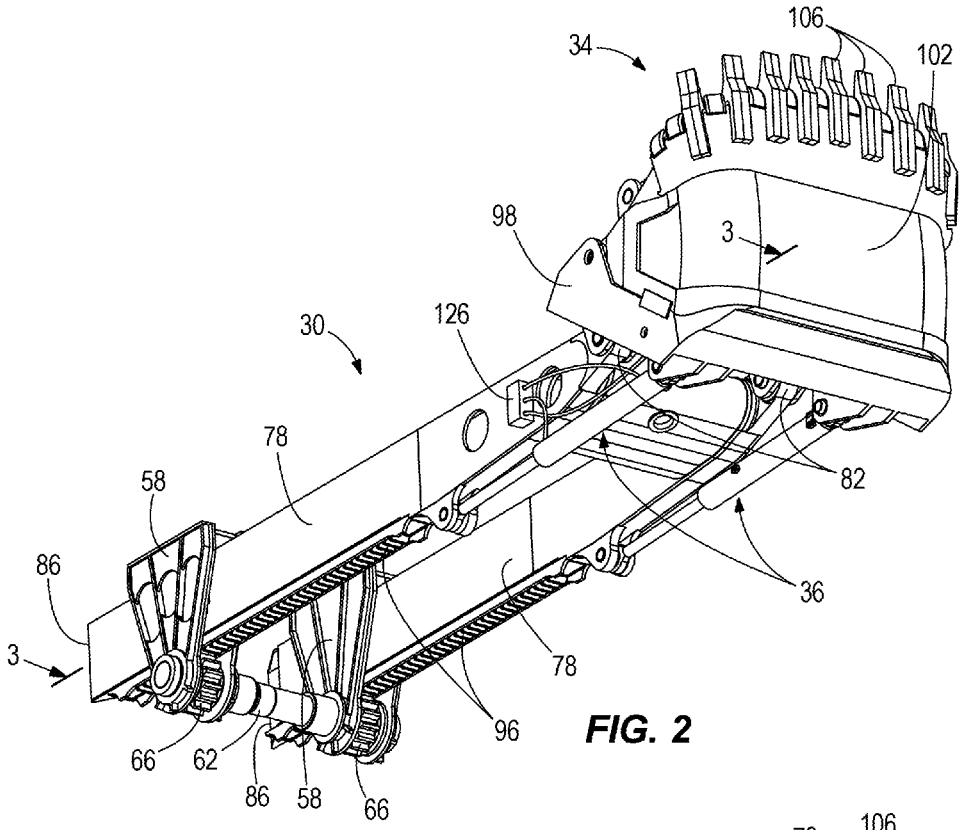

106
34
102
98
3
30
126
78
58
82
86
36
3
78
96
66
62
86
58
66

FIG. 2

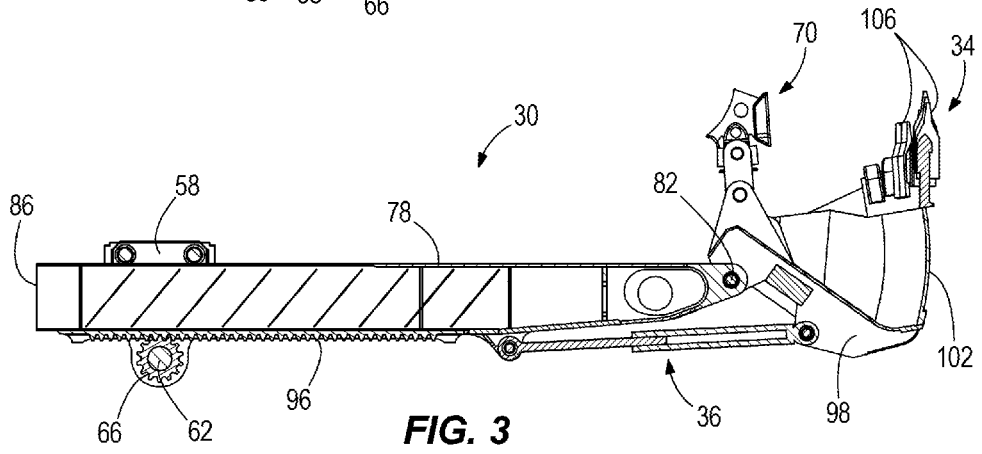

70
106
34
30
86
58
78
82
102
96
36
98
66
62

FIG. 3

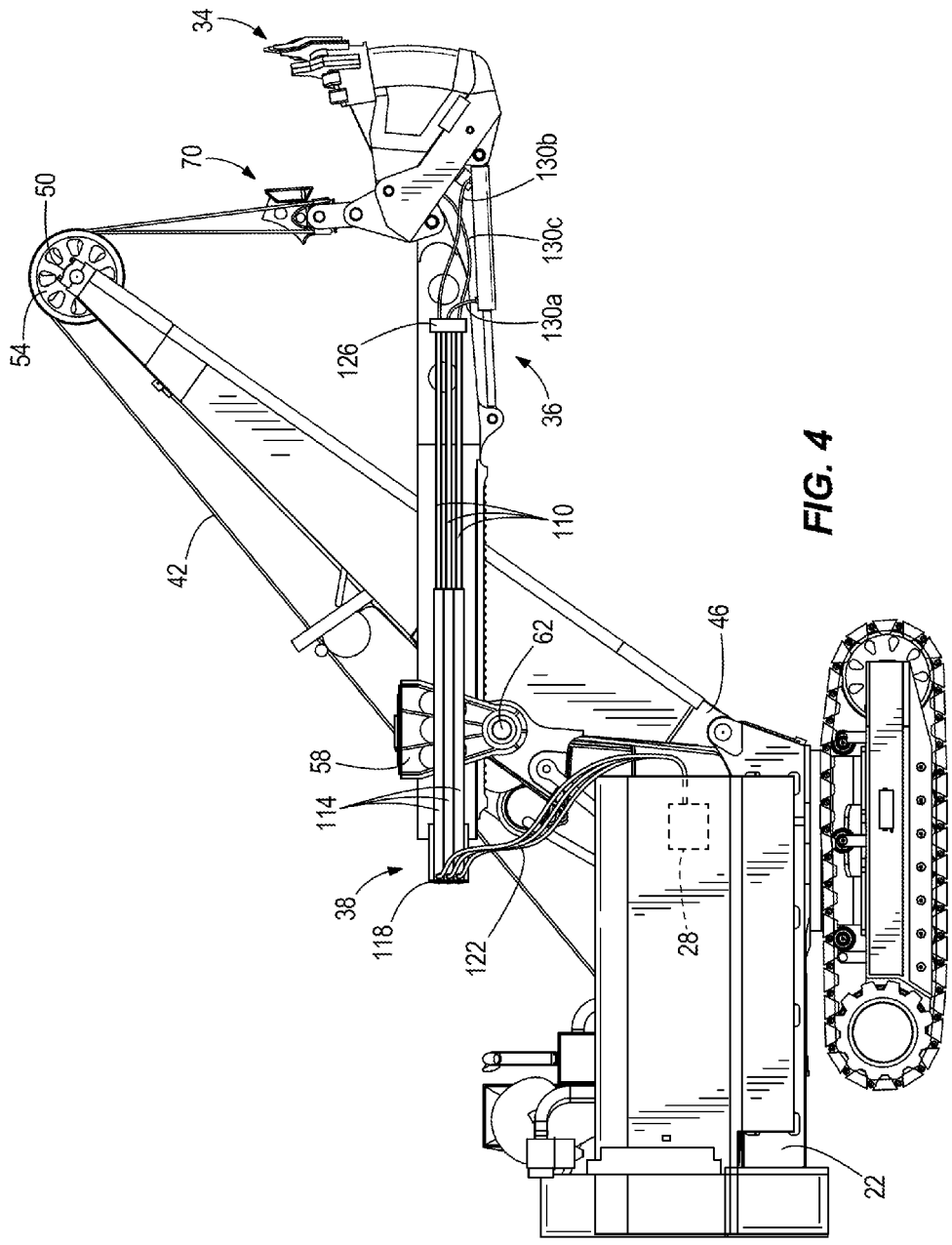

34
70
50
54
130b
130c
130a
126
36
110
42
62
46
58
114
38
118
122
28
22

FIG. 4

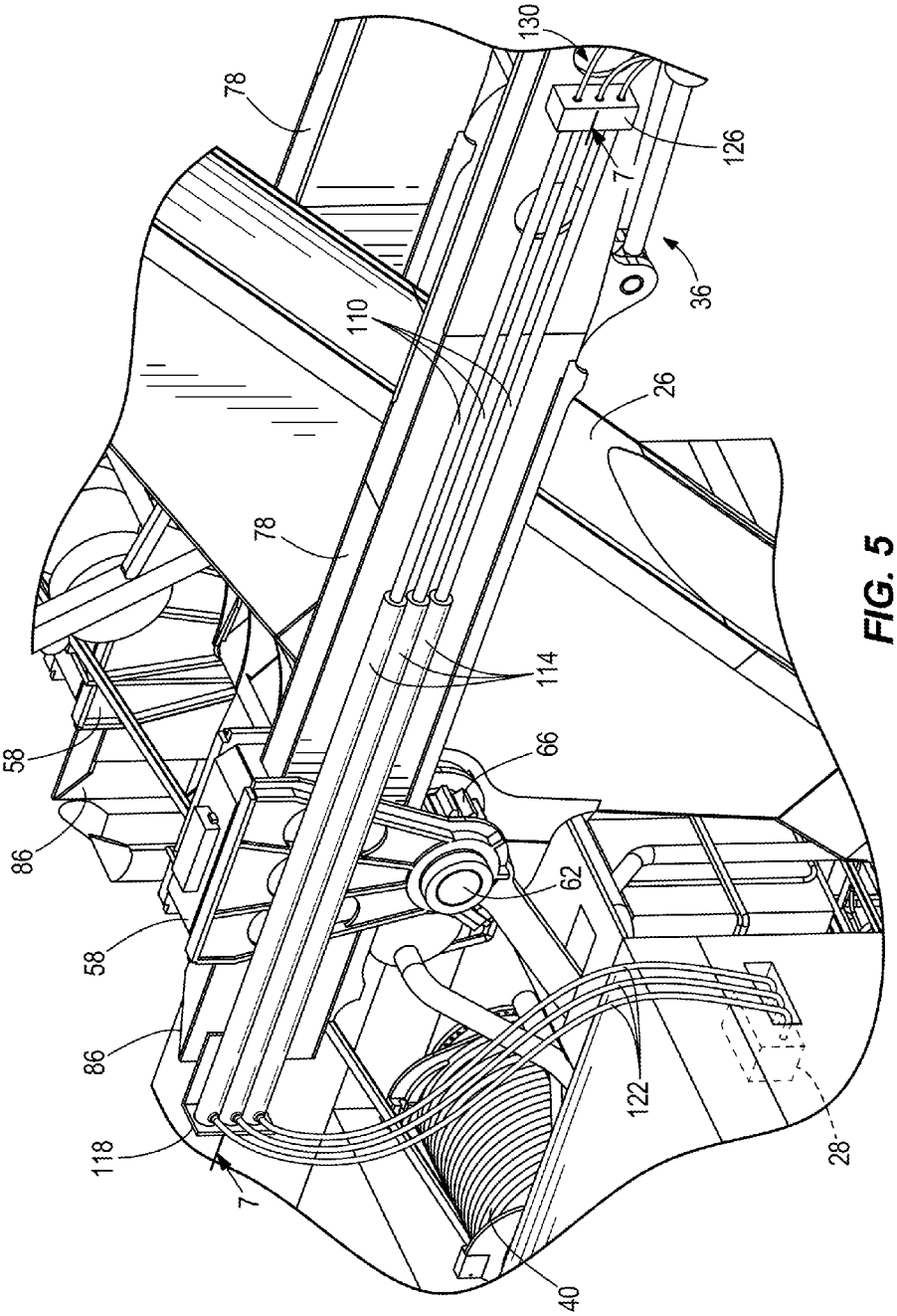


FIG. 5

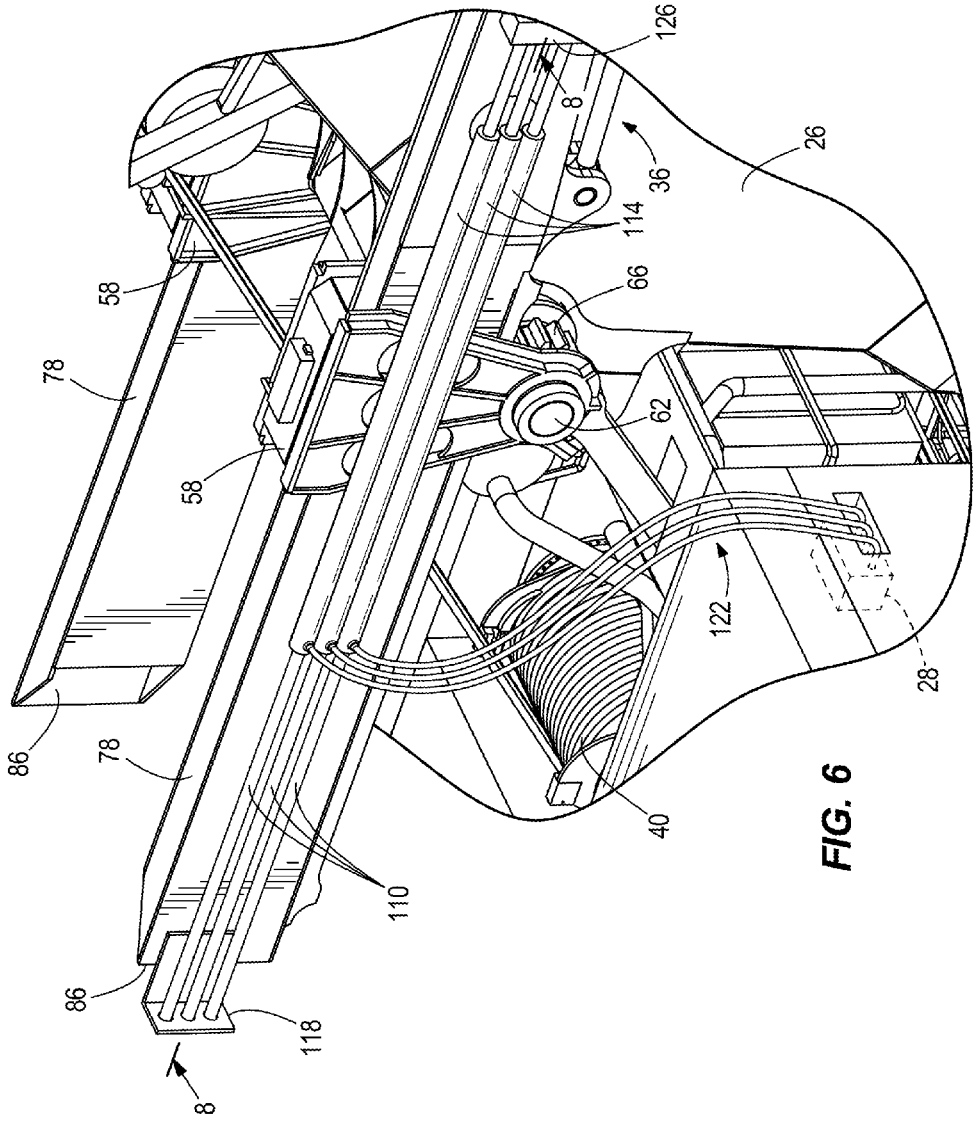


FIG. 6

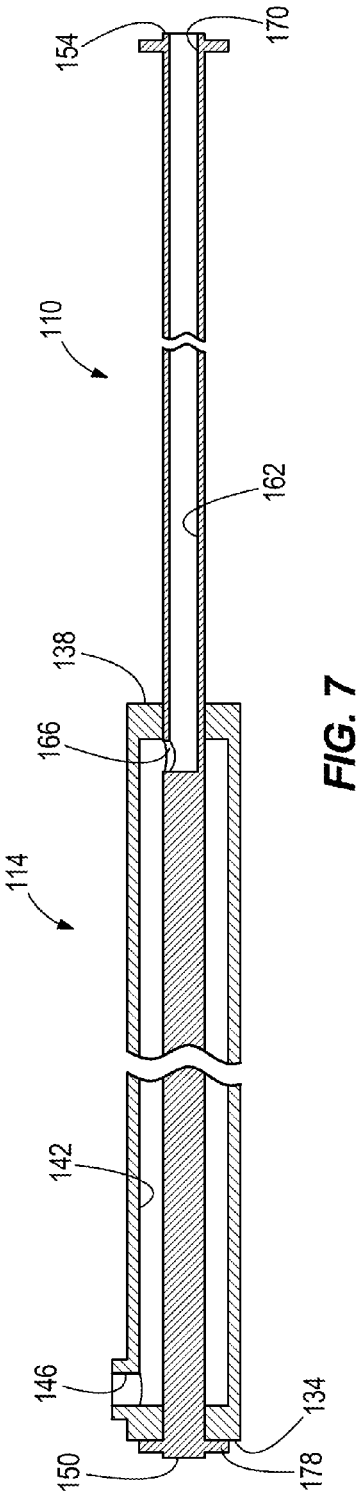

154
170
110
162
138
166
114
142
146
134
150
178

FIG. 7

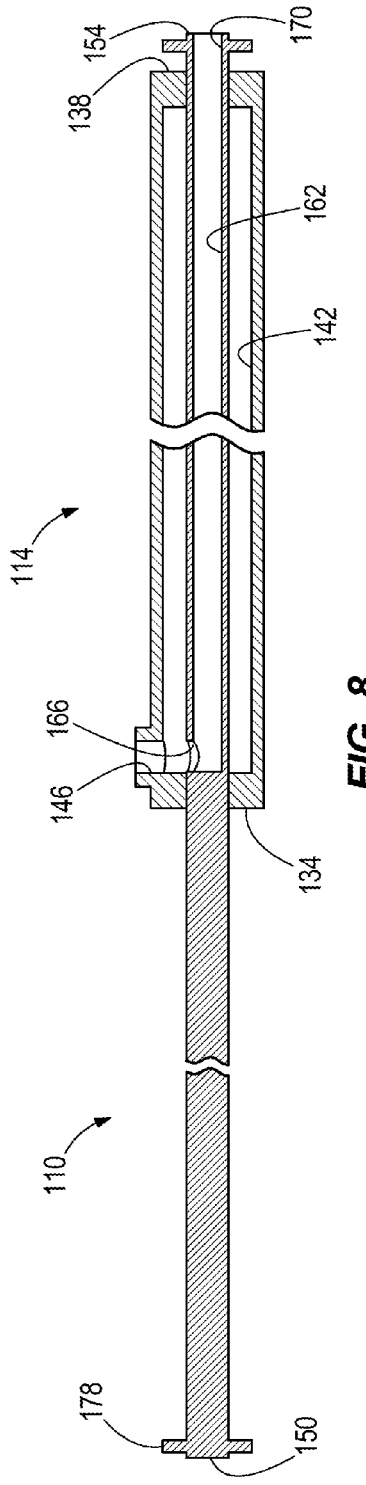

154
170
138
162
142
114
166
146
134
110
178
150

FIG. 8

FLUID CONVEYANCE SYSTEM

CROSS REFERENCE TO RELATED APPLICATION

This application claims the benefit of and priority to U.S. Provisional Patent Application No. 61/716,072, filed Oct. 19, 2012, the entire contents of which is incorporated by reference herein.

BACKGROUND

The present invention relates to industrial machines. Specifically, the present invention relates to a fluid conveyance system for an earthmoving machine attachment.

Conventional rope shovels include a frame supporting a boom and a handle coupled to the boom for rotational and translational movement. A dipper is attached to the handle and is supported by a cable or rope that passes over an end of the boom. The rope is secured to a bail that is pivotably coupled to the dipper. During the hoist phase, the rope is reeled in by a hoist drum, lifting the dipper upward through a bank of material and liberating a portion of the material. The orientation of the dipper relative to the handle is generally fixed and cannot be controlled independently of the handle and the hoist rope.

SUMMARY

In one aspect, the invention provides an industrial machine including a frame supporting a fluid source and a boom, an arm, an attachment coupled to the arm, a cylinder, and a rod. The arm is movably coupled to the boom for translational and rotational movement relative to the boom. The cylinder includes a first end and a second end, and the cylinder defines an internal bore in fluid communication with the fluid source. The rod is coupled to the arm and is slidably received within the cylinder. The rod includes a port and a passage for providing fluid to the attachment. The port provides fluid communication between the internal bore and the passage. The port is positioned within the internal bore throughout the entire range of movement of the rod relative to the cylinder.

In another aspect, the invention provides an industrial machine including a frame, an elongated arm, an attachment, a first member, and a second member. The frame supports a boom and a fluid source. The boom includes a first end and a second end opposite the first end. The elongated arm is movably coupled to the boom and includes a first end and a second end. The attachment is coupled to the first end of the elongated member. The first member has a first end and a second end and defines a first chamber in fluid communication with the fluid source. The second member at least partially extends through the first member. The second member includes a second chamber in fluid communication with the first chamber and in fluid communication with the attachment. The second member is movable relative to the first member as the arm moves relative to the boom.

In yet another aspect, the invention provides a fluid conveyance system for an industrial machine, the industrial machine having a frame supporting a boom including a saddle block, an arm having a first end and a second end and supported by the saddle block for movement relative to the boom, and an attachment coupled to the second end of the arm. The fluid conveyance system includes a fluid source, a conduit in fluid communication with the fluid source, a cylinder, and a rod slidably received within the cylinder. The cylinder includes a first end and a second end and defines an internal bore in fluid communication with the conduit. The rod is slidably received within the cylinder and supported by the arm. The rod includes a port and a passage for providing fluid to the attachment. The port provides fluid communication between the internal bore and the passage and is positioned within the internal bore throughout the range of movement of the rod relative to the cylinder.

Other aspects of the invention will become apparent by consideration of the detailed description and accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a shovel.

FIG. **2** is a perspective view of a handle, a saddle block, a shipper shaft, and a bucket.

FIG. **3** is a section view of the handle, saddle block, shipper shaft, and bucket of FIG. **2** taken along section **3-3**.

FIG. **4** is a side view of the shovel of FIG. **1**.

FIG. **5** is a perspective view of a fluid conveyance system with the handle extended.

FIG. **6** is a perspective view of the fluid conveyance system with the handle retracted.

FIG. **7** is a cross section view of a cylinder and a rod of the fluid conveyance system shown in FIG. **5** taken along section **7-7**.

FIG. **8** is a cross section view of the cylinder and the rod of the fluid conveyance system shown in FIG. **6** taken along section **8-8**.

Before any embodiments of the invention are explained in detail, it is to be understood that the invention is not limited in its application to the details of construction and the arrangement of components set forth in the following description or illustrated in the following drawings. The invention is capable of other embodiments and of being practiced or of being carried out in various ways. Also, it is to be understood that the phraseology and terminology used herein is for the purpose of description and should not be regarded as limiting.

DETAILED DESCRIPTION

As shown in FIG. **1**, a mining shovel **10** is supported by tracks **14** on a support surface or ground (not shown). The shovel **10** includes frame **22** supporting a boom **26** and a fluid source **28** (e.g., a fluid pump or tank), an elongated member or handle **30**, an attachment or bucket **34** including pivot actuators **36**, and a fluid conveyance system **38**. The frame **22** includes a rotational structure for rotating about an axis of rotation (not shown) that is generally perpendicular to a plane corresponding to a grade of the support surface. The frame **22** also includes a hoist drum **40** for reeling in and paying out a cable or rope **42**.

The boom **26** includes a first end **46** coupled to the frame **22**, a second end **50** opposite the first end **46**, a boom sheave **54**, saddle blocks **58**, and a shipper shaft **62**. The boom sheave **54** is coupled to the second end **50** of the boom **26** and guides the rope **42** over the second end **50**. The rope **42** is coupled to the bucket **34** by a bail **70**, and the bucket **34** is raised or lowered as the rope **42** is reeled in or paid out, respectively, by the hoist drum **40**. The shipper shaft **62** extends through the boom **26** and is positioned between the first end **46** and the second end **50** of the boom **26**. In the illustrated embodiment, the shipper shaft **62** is rotatable about an axis defined by the shipper shaft **62** and is oriented transverse to a longitudinal axis of the boom **26**. The shipper shaft **62** includes one or more pinions **66** (FIG. **2**). The saddle blocks **58** are rotatably coupled to the boom **26** by the shipper shaft **62**. In one

embodiment, each saddle block **58** is a three-piece saddle block having two parallel side portions and a top portion extending between the side portions.

As shown in FIGS. **2** and **3**, the handle **30** includes a pair of parallel arms **78** and defines a first end **82** and a second end **86**. The first end **82** is pivotably coupled to the bucket **34**. The second end **86** is movably received in the saddle blocks **58**, which is rotatable relative to the boom **26** (FIG. **1**) about the shipper shaft **62**. In the illustrated embodiment, the handle arms **78** are positioned on either side of the boom **26** and movably pass through each saddle block **58** such that the handle **30** is capable of rotational and translational movement relative to the boom **26**. Stated another way, the handle **30** is linearly extendable relative to the saddle block **58** and is rotatable about the shipper shaft **62**. In addition, each arm **78** includes a rack **96** for engaging the pinion **66** of the shipper shaft **62**, forming a rack-and-pinion coupling between the handle **30** and the boom **26** (FIG. **1**). Rotation of the shipper shaft **62** about its axis moves the rack **96** along the shipper shaft **62**, facilitating translational movement of the handle **30** relative to the boom **26**.

In the illustrated embodiment, the bucket **34** is a clamshell-type bucket **34** having a rear wall **98** and a main body **102** that can be separated from the rear wall **98** to empty the contents of the bucket **34**. The main body **102** may be actuated by one or more bucket cylinders (not shown). In other embodiments, the shovel **10** may include other types of attachments, buckets, or dippers. Each pivot actuator **36** is coupled between the bucket **34** and the handle **30**. The pivot actuators **36** actively control the pitch of the bucket **34** (i.e., the angle of the bucket **34** relative to the handle **30**) by rotating the bucket **34** about the handle first end **82**. In the illustrated embodiment, the pivot actuators **36** are hydraulic cylinders. The bucket **34** also includes teeth **106** for engaging a bank of material. The bucket **34** is used to excavate a desired work area, collect material, and transfer the collected material to a desired location (e.g., a material handling vehicle).

Referring to FIGS. **4-6**, the fluid conveyance system **38** includes rods **110**, hollow cylinders **114**, and a rod support **118** positioned proximate an end of the cylinders **114**. In the illustrated embodiment, each rod **110** is coupled to the handle **30**, each cylinder **114** is coupled to the saddle block **58**, and the rod support **118** is coupled to the second end **86** of the handle **30**. Each cylinder **114** is in fluid communication with a first conduit **122**. Each rod **110** extends through one of the cylinders **114** and is slidable with respect to the cylinder **114**. The rod support **118** guides and supports the ends of the rods **110** exiting from the ends of the cylinders **114**, thereby maintaining the alignment between the rods **110** and the cylinders **114**. The rods **110** are also coupled to a manifold **126** positioned proximate the first end of the handle **30**. In the illustrated embodiment, the fluid conveyance system **38** includes three rods **110** and three cylinders **114**; in other embodiments, the system **38** may include fewer or more rods **110** and cylinders **114**. In some embodiments, the fluid conveyance system **38** is positioned on both sides of the handle **30**.

In the illustrated embodiment, the manifold **126** provides fluid communication between the rods **110** and the lines **130**, which provide pressurized fluid to actuate the bucket **34** or other attachment. In one embodiment, lines **130***a*, **130***b* (FIG. **4**) are in fluid communication with the pivot actuators **36** and line **130***c* (FIG. **4**) is in fluid communication with a bucket actuator (not shown). In some embodiments, the lines **130** are in fluid communication with various mechanical connections (e.g., pin joints) on the bucket **34** and/or handle **30** and provide lubricative fluid to the connections. The lubricative fluid may be a liquid, solid, and/or semi-solid (e.g., grease). Alternatively, the cylinders **114** may convey multiple types of fluid (e.g., one cylinder conveys hydraulic fluid while another cylinder **114** conveys lubricative fluid).

As shown in FIGS. **7** and **8**, each cylinder **114** defines a first end **134** and a second end **138**. The cylinder **114** includes a first chamber or bore **142** and a cylinder port **146** providing fluid communication between the bore **142** and the first conduit **122** (FIG. **6**). Each rod **110** defines a first end **150** and a second end **154**. The rod **110** includes a second chamber or passage **162**, a first rod port **166**, and a second rod port **170**. In the illustrated embodiment, the passage is formed as a hollow core extending at least partially through the rod **110**. The first rod port **166** is positioned within the cylinder **114** and provides fluid communication between the bore **142** and the passage **162**. The second rod port **170** is positioned proximate the first end **150** of the rod **110** and is in fluid communication with the manifold **126**. In the illustrated embodiment, the first end **134** of each rod **110** also includes a stop or end cap **178** to limit the range of movement of the rod **110** relative to the cylinder **114**. In other embodiments, the rod **110** may also include a stop positioned proximate the second end **138**.

The first rod port **166** is positioned such that the first rod port **166** is always within the bore **142** during the full stroke of the rod **110**, thereby insuring that the first rod port **166** always provides fluid communication between the bore **142** and the rod passage **162**. Each end of the bore **142** is sealed to prevent fluid from leaking between the rod **110** and the cylinder **114**. In one embodiment, the bore **142** is sealed against the rod **110** by radial seals extending between an inner surface of the bore **142** and an outer surface of the rod **110**.

The handle **30** is extended or crowded so that the bucket **34** engages a bank of material. As the handle **30** moves away from the boom **26** toward an extended position (FIG. **5**), each rod **110** slides relative to its respective cylinder **114** such that the first end **150** of the rod **110** moves away from the boom **26**. Alternatively, as the handle **30** moves away from the bank toward a retracted position (FIG. **6**), each rod **110** slides relative to its respective cylinder **114** such that the first end **150** of the rod **110** moves toward the boom **26**. The retraction of the handle **30** causes the rods **110** to slide outwardly from the second end **138** of the cylinder **114** (FIG. **8**). The rod support **118** supports the weight of the rods **110** as the rods **110** exit the cylinders **114** and maintains the rods **110** in alignment with the bores **142** (FIG. **8**) of the cylinders **114**.

Each first rod port **166** remains in fluid communication with the bore **142** during the entire stroke of the rod **110**. Fluid flows from the source **28** via the first conduit **122**, through the cylinder **114** via the cylinder port **146** and into the rod **110** via the first rod port **142**. The fluid flows through the passage **162** and into the manifold **126**, where it is then distributed to the actuators or lubrication points. The fluid conveyance system **38** thus transmits the fluid along the length of the handle **30** to the bucket **34** while accommodating the range of motion of the handle **30**.

The bore **142** of the cylinder **114** provides a constant volume chamber, and the fluid in the bore **142** operates at a predetermined pressure that is substantially equal to the fluid pressure in the rod passage **162** at all times regardless of the extension of the handle **30**. In addition, the fluid conveyance system **38** avoids the use of fluid hose that can be difficult to control and may snag on nearby obstacles or structures.

Thus, the invention provides, among other things, a fluid conveyance system for an industrial machine. Although the invention has been described in detail with reference to certain preferred embodiments, variations and modifications exist within the scope and spirit of one or more independent

aspects of the invention as described. Various features and advantages of the invention are set forth in the following claims.

What is claimed is:

1. An industrial machine comprising:

a frame supporting a fluid source and a boom;

an arm movably coupled to the boom for translational and rotational movement relative to the boom;

an attachment coupled to the arm;

a cylinder including a first end and a second end, the cylinder defining an internal bore in fluid communication with the fluid source; and

a rod coupled to the arm and slidably received within the cylinder, the rod including a port and a passage for providing fluid to the attachment, the port providing fluid communication between the internal bore and the passage, the port positioned within the internal bore throughout the entire range of movement of the rod relative to the cylinder,

wherein the frame includes a saddle block pivotably coupled to the boom and supporting the arm for movement relative to the boom, wherein the cylinder is supported on the saddle block.

2. The industrial machine of claim **1**, wherein the rod slidably extends through the first end and the second end of the cylinder, wherein translational movement of the arm relative to the boom causes the rod to slide relative to the cylinder.

3. The industrial machine of claim **1**, further comprising a support bracket coupled to the arm proximate the second end, the support bracket supporting an end of the rod extending through the cylinder.

4. The industrial machine of claim **1**, wherein the attachment includes a bucket coupled to the first end of the arm and an actuator for actuating the bucket, wherein the passage of the rod is in fluid communication with a conduit for supplying fluid to the actuator.

5. The industrial machine of claim **1**, wherein the attachment is a bucket supported by a hoist cable extending over an end of the boom.

6. The industrial machine of claim **1**, further comprising a support bracket secured to the arm and supporting an end of the rod.

7. The industrial machine of claim **1**, wherein the frame supports the fluid source independently of the arm.

8. An industrial machine comprising:

a frame supporting a boom and a fluid source, the boom including a first end and a second end opposite the first end;

an elongated arm movably coupled to the boom, the elongated arm including a first end and a second end;

an attachment coupled to the first end of the elongated arm;

a first member coupled to the frame and having a first end and a second end, the first member defining a first chamber in fluid communication with the fluid source; and

a second member at least partially extending through the first member, the second member including a second chamber in fluid communication with the first chamber and in fluid communication with the attachment, the second member movable relative to the first member as the arm moves relative to the boom,

wherein the frame includes a saddle block pivotably coupled to the boom and supporting the arm for translational movement relative to the boom, wherein the first member is supported on the saddle block.

9. The industrial machine of claim **8**, wherein the first member is a cylinder and the second member is a rod including a hollow core.

10. The industrial machine of claim **8**, wherein the first member is pivotable with respect to the boom, and wherein the second member is coupled to the arm.

11. The industrial machine of claim **8**, wherein the second member slidably extends through the first end and the second end of the first member, wherein translational movement of the arm relative to the boom causes the second member to slide relative to the first member.

12. The industrial machine of claim **11**, wherein the second member includes a port that is positioned within the first chamber throughout the entire range of movement of the second member relative to the first member, the port providing fluid communication between the first chamber and the second chamber.

13. The industrial machine of claim **11**, further comprising a support bracket coupled to the arm proximate the second end, the support bracket supporting an end of the second member extending through the first member.

14. The industrial machine of claim **8**, wherein the attachment includes a bucket coupled to the first end of the arm and an actuator for actuating the bucket, wherein the second chamber of the second member is in fluid communication with the actuator.

15. The industrial machine of claim **14**, further comprising a manifold coupled to the arm proximate the first end, wherein the second chamber supplies fluid to the manifold from the fluid source via the first chamber.

16. The industrial machine of claim **8**, further comprising a support bracket secured to the arm and supporting an end of the second member.

17. The industrial machine of claim **8**, wherein the frame supports the fluid source independently of the arm.

18. A fluid conveyance system for an industrial machine, the industrial machine having a frame supporting a boom including a saddle block, an arm having a first end and a second end and supported by the saddle block for movement relative to the boom, and an attachment coupled to the second end of the arm, the fluid conveyance system comprising:

a fluid source;

a conduit in fluid communication with the fluid source;

a cylinder including a first end and a second end, the cylinder defining an internal bore in fluid communication with the conduit; and

a rod slidably received within the cylinder and supported by the arm, the rod including a port and a passage for providing fluid to the attachment, the port providing fluid communication between the internal bore and the passage, the port positioned within the internal bore throughout the range of movement of the rod relative to the cylinder,

wherein the rod extends through the first end and second end of the cylinder, the rod including a first end and a second end, the first end of the rod positioned proximate the first end of the cylinder and the second end of the rod positioned proximate the second end of the cylinder.

19. The fluid conveyance system of claim **18**, further comprising a manifold in fluid communication with the attachment, wherein the passage is positioned proximate the first end of the rod in fluid communication with the manifold.

20. The fluid conveyance system of claim **19**, further comprising a support bracket supporting the rod proximate the second end.

* * * * *